

CASE STUDY REPORT #37
NICASIO LAKE
NICASIO CREEK

I. Project Description

The 36 square mile Nicasio Creek Drainage is located in the coastal area of Marin County, California. This creek is the primary tributary of Lagunitas Creek which enters the Pacific Ocean at the head of Tomales Bay (see Figure 1).

Nicasio Dam is located approximately one mile upstream from the confluence of Nacasio and Lagunitas Creeks. The dam was constructed in 1960 by the Marin Municipal Water District (MMWD). Water stored for municipal use in the water district is not released to the stream but diverted from the reservoir by pumps to cities in Southern Marin County.

Storage capacity in Nicasio Reservoir is 22,500 acre-feet covering 850 acres.

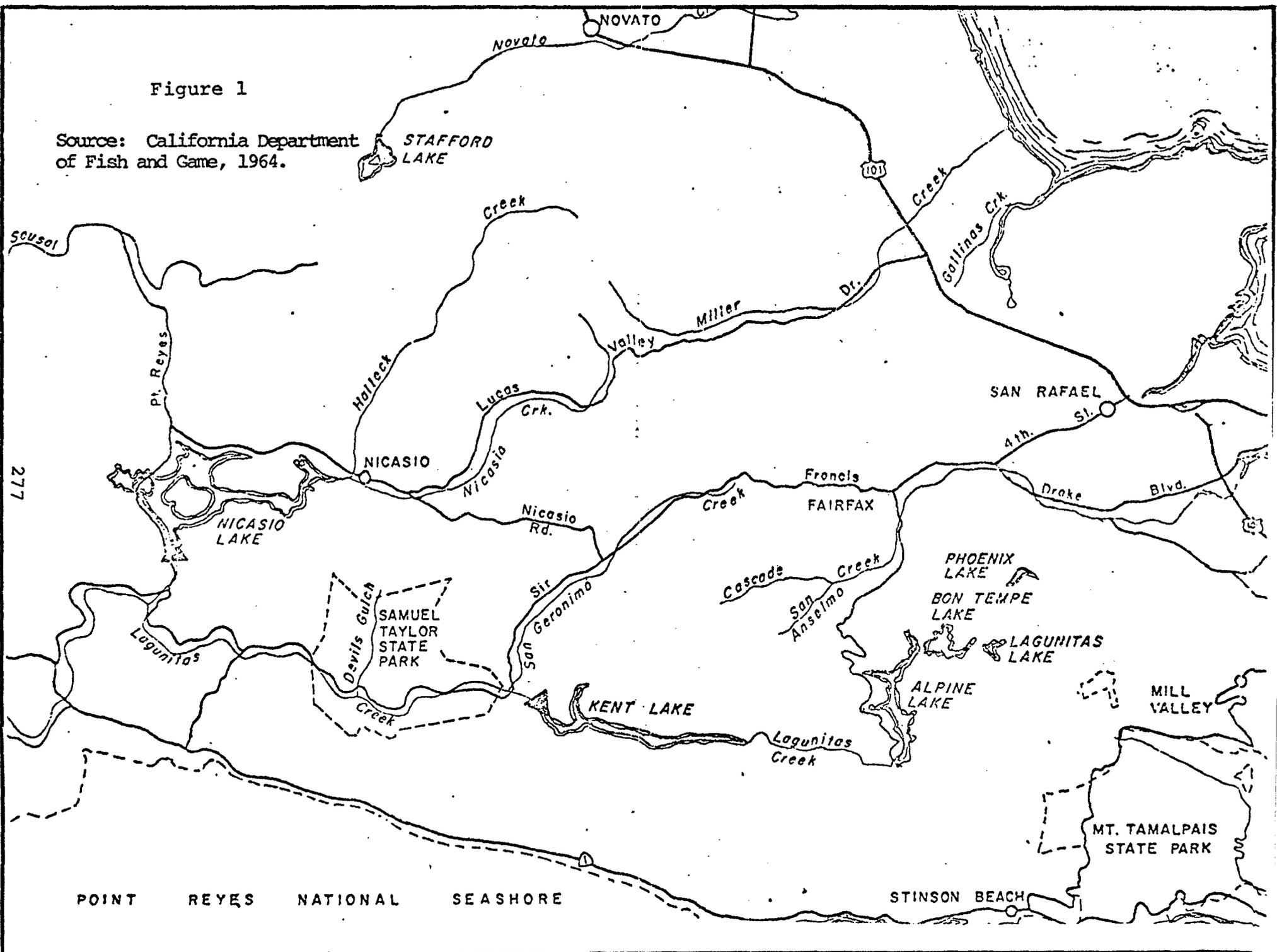
II. Pre-Project Condition

The major natural streamflow in Nicasio Creek generally occurs during the wet season from mid-November to late May (see Figure 2). During periods of heavy rains stream flows fluctuate widely.

Storm flows stimulate the upstream migration of steelhead and silver salmon from Tomales Bay into Lagunitas Creek and Nicasio Creek. Historically the Nicasio Creek drainage supported fairly large spawning runs of steelhead and silver

Figure 1

Source: California Department of Fish and Game, 1964.

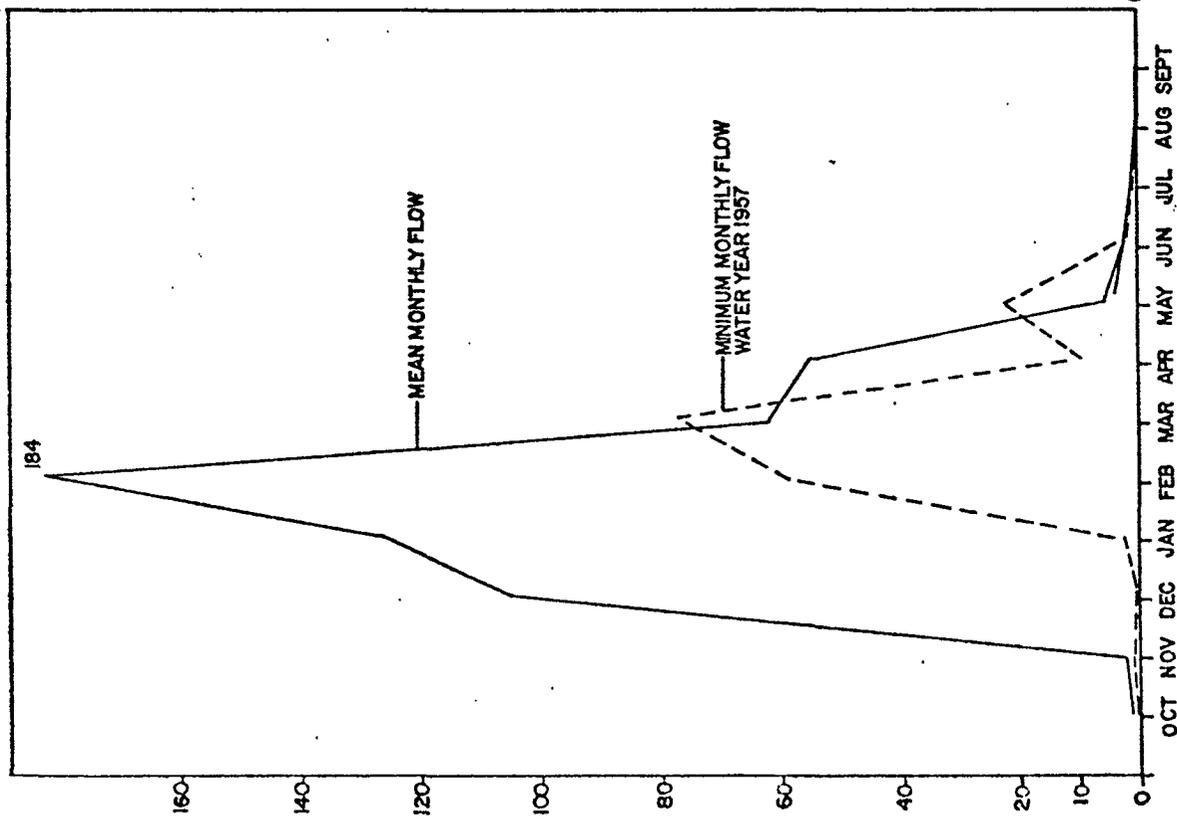


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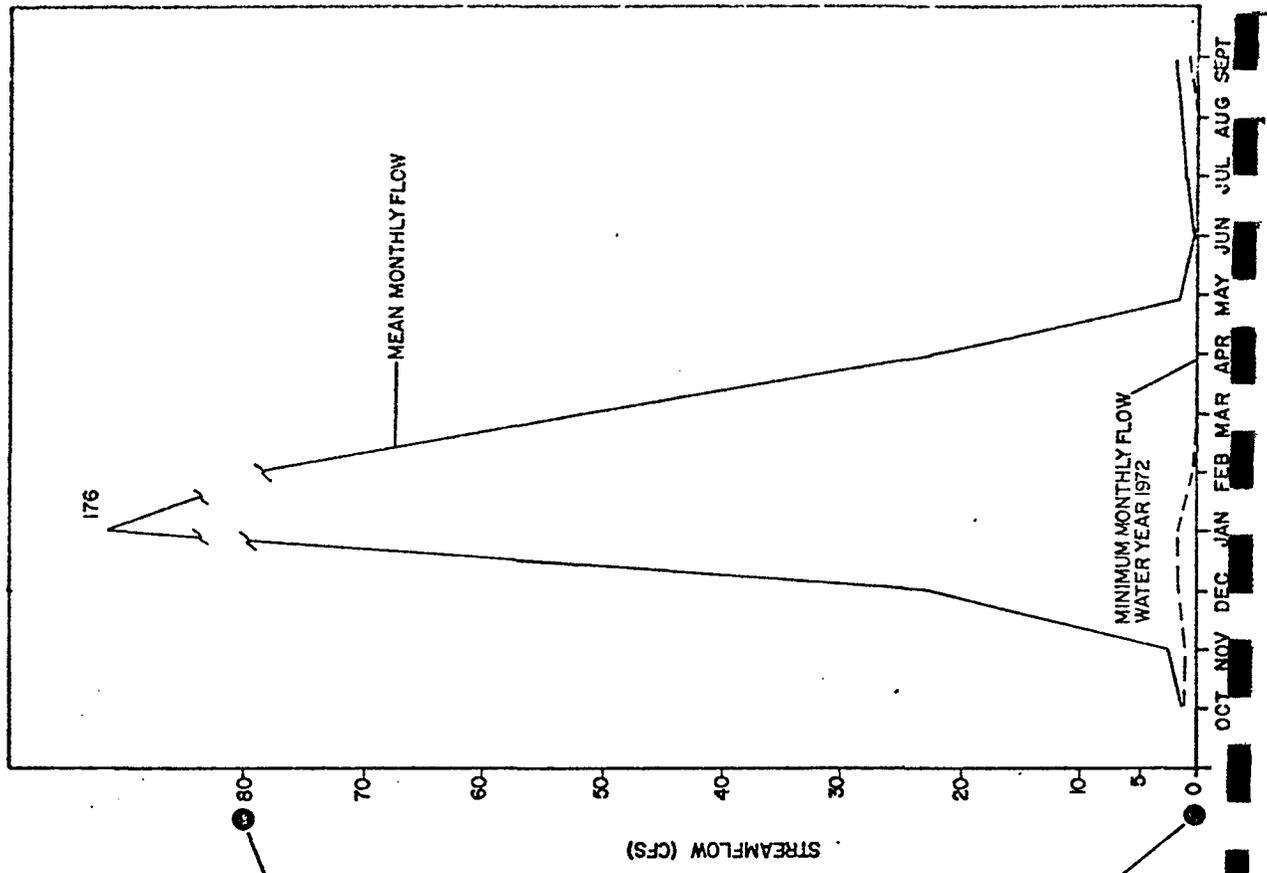
STINSON BEACH



PRE-PROJECT: OCTOBER 1955 - SEPTEMBER 1959
 GAUGE STATION NO.
 SOURCE: USGS UNPUBLISHED DATA

FIGURE 2
 STREAMFLOW CONDITIONS, NICASIO CREEK
 NICASIO RESERVOIR

POST-PROJECT: OCTOBER 1961 - SEPTEMBER 1974
 GAUGE STATION NO.
 SOURCE: USGS OUTFLOW DATA (PRELIMINARY DATA)



salmon. These anadromous fish spawned throughout the entire length of Nicasio Creek and its headwater tributaries.

A pre-project survey was conducted by the Department of Fish and Game (1958) to determine the miles of stream available to spawning salmon and steelhead in the Nicasio Creek Drainage. The results of the survey follow:

Class I area (Annual use)	Miles
1. Nicasio Creek above and below damsite	5.5
2. Halleck Creek	1.5
3. Unnamed tributary Halleck Creek	.5
4. Unnamed tributaries Nicasio Creek, Farley- Isaacs Ranches	<u>1.5</u>
	9.0

Class II (Use on wet years only)

1. Unnamed tributaries Nicasio Creek	4.5
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Lagunitas Creek contains an equal amount of spawning areas as compared to the Nicasio drainage. During pre-project conditions the limit of upstream spawning migrations on Lagunitas Creek was Peters Dam located approximately 22 miles above the mouth at Tomales Bay. In consideration of available habitat Nicasio Creek supported approximately half of the population of anadromous fish entering Lagunitas Creek at Tomales Bay.

The winter sport fishery provided in the tidewater areas of Lagunitas Creek were considered by the Department of Fish and Game (1959) to be the most important silver salmon

steelhead fishery in Marin County. This stream was one of the most available high quality sport fishery streams in the general vicinity of San Francisco. During favorable stream discharge conditions anglers used this fishery all through the season, which extended from November 1st through February 28th. Season estimates made by Department of Fish and Game wildlife protection officers placed the total use during the 1954-55 winter at 2,163 angler days.

No pre-project counts or estimates of the number of steelhead and salmon entering Nicasio Creek drainage were found from the data reviewed.

III. Project Development

In order to meet the water supply requirements of the Marin Municipal Water District the district applied for water rights on Nicasio Creek in 1955 (Application no. 17317).

A Department of Fish and Game office memorandum (1958) assessed the proposed Nicasio Creek water program and its effect on the existing fishery. At that time it was expected that the reservoir would fill and spill an average of 6,000 acre-feet over an extended period of three to four months each winter. Nicasio Reservoir was expected to inundate nearly 3 miles of Nicasio Creek.

The principal effect of the project was the creation of an impassible barrier to upstream migrating silver salmon and steelhead. The loss of nearly 20 miles of spawning and

nursery habitat by blockage and inundation would result in an anticipated reduction of 50 percent of the salmon and steel-head populations entering Lagunitas Creek from Tomales Bay.

The fishery management plan proposed by the Department of Fish and Game in 1958 to preserve the fishery resources of Nicasio and Lagunitas Creeks is outlined below:

"Water releases should be provided which will:

- (1) Permit fish to migrate up Nicasio Creek during winter months to a trap near the base of the dam.
- (2) Permit juvenile fish opportunity to return to the ocean annually for a several months period. Reservoir spill will be during the winter months rather than the normal spring migration period.

"Establish a trapping and transporting facility to allow fishes to continue winter spawning migration above Nicasio Dam."

In accordance with this management plan it was recommended that an agreement be negotiated with the MMWD that would include the following proposed terms:

"Maintenance of minimum flows in Nicasio Creek below Nicasio Dam as follows:

December 1 through March 31	100 cfs or 6000 af
April 1 through May 31	10 cfs or <u>600</u> af
	6600 af

"In addition, the Department recommended that water releases be made from the lower levels of the reservoir to insure low temperatures suitable for fishlife. A summer flow release was not requested. Other recommendations included District construction, operation and maintenance of fish trapping facilities in the stream immediately below the reservoir and in 2 tributary streams immediately above the reservoir."

The methodology employed for recommending minimum instream flows was based on observations made along Nicasio Creek during known stream flows. Recommended flows would provide the spawning habitat that was quantified during the stream surveys taken earlier. Also recommended flows were judged sufficient to provide passage and attraction to fish traps located one mile upstream.

The streamflows from the Nicasio project as negotiated in the July 21, 1960 agreement required the District to release 800 acre-feet of water (approximately 14 cfs mean monthly flow) from November 1 through March 31. The water is to be made available the first of each month and released at increments specified by the Department of Fish and Game.

During a dry year if the mean runoff recorded for the previous month is 50 percent of the computed mean monthly runoff, the District is permitted to release 600 acre-feet (approximately 10 cfs mean monthly flow). During a critical dry year if the mean runoff of any previous month of this period is 20 percent of the computed mean monthly runoff the District and the Department are to negotiate the matter.

The Marin Municipal Water District was further required by the terms of the agreement to maintain low temperatures in the water released from Nicasio Dam. Also the spillway at the dam was required to be designed and constructed such that it would reduce the chances of injury to downstream migrant fish.

From the documents reviewed no reason was revealed describing the difference between the flows required in the agreement and the flows that were recommended by the Department of Fish and Game. A 1969 letter in the Department of Fish and Games files suggested a possibility that the full amount of recommended flows was not received due to negotiation compromises concerning the anadromous fisheries mitigative features of the Nicasio Project.

According to the 1960 agreement, the District was required to construct and operate fish trapping facilities to relocate spawning fish blocked by the dam. These fish were to be transported by the District to areas above the dam.

In October of 1961 new terms of the mitigation features of the Nicasio project were set forth in the form of a 5-year supplementary agreement between the Department of Fish and Game and MMWD that was supplementary to the 1960 agreement.

This supplemental agreement required the District to construct a fish trap below the dam for the collection of upstream spawning adults, and downstream traps for the collection of juvenile salmon and steelhead on the two major tributaries of Nicasio Reservoir. These facilities were to be operated by the Department of Fish and Game on contract for the MMWD. Fish that were trapped below the dam were transported by tank truck to spawning and nursery areas above the reservoir.

During the time period of this first supplementary agreement the District was incurring costs for production of juvenile fish slightly less than \$1.00 per fish. This was higher than the Department of Fish and Game cost to maintain fish runs on other streams in the state. It was thought by the District at that time that it would be more economical to plant 10,000 steelhead and silver salmon below the dam than to pay the total costs for the trap and transport operation.

The first supplementary agreement expired in October of 1966. In 1968 a new supplementary agreement was negotiated. The terms of this supplement required the MMWD to reimburse the state annually for costs incurred by the state for providing fish maintenance service. The agreement did allow for renegotiation at a later date if a hatchery to rear young salmonids becomes available. In such a case a substitute or alternative to the agreement could be designed if it was determined more economical to maintain the fish run by artificial propagation.

The terms of that supplement expired in October 1971. In January 1973, a new supplementary agreement to the July 1960 agreement was negotiated. In the interim, the trap and transport operation was continued. The terms of this agreement require the district to pay for the stocking of 5,000 steelhead and 40,000 silver salmon fingerlings annually; also, the state can operate the fish trap at any time.

All of the agreements concerning the fish flow releases and the mitigative features of the Nicasio project are included in the terms of the State Water Rights Permit issued to the MMWD.

IV. Post-Project

The operation of the Nicasio Dam Project has altered the winter and summer streamflow patterns from the natural flow regime. Storage of flows during the winter runoff has, on the average, reduced the magnitude of winter streamflow; however, during a minimum flow year stream flow conditions are greatly reduced (see Figure 2).

The operation of Nicasio Dam provides a greater than natural minimum summer stream flow. This is due to releases of up to 2 cfs from Nicasio Dam to fulfill downstream water rights on Lagunitas Creek. Stream flows for this downstream requirement are provided by dividing releases between Kent Lake (on Lagunitas Creek) (see Case Study #38) and Nicasio Reservoir. The MMWD is not obligated by the terms of the stream flow agreement to maintain any instream flow for fish in Nicasio Creek during the summer.

During normal rainfall and runoff years the Department of Fish and Game has had the opportunity to experiment with release patterns that provide stream flows for upstream migrating silver salmon and steelhead. During the five months of required fish flow releases (November through March) the Department of

Fish and Game has successfully provided streamflow patterns suitable for the attraction and passage of salmon and steelhead to the trap below the dam site. These modulated flow patterns are not shown on the stream flow hydrograph due to the averaging technique employed in graph construction.

Throughout the operation of the dam and trapping facilities, simulation of storm stream flow patterns such as surge flows released from the dam, were found by the Department of Fish and Game to attract upstream migrant salmonids to the trap at the base of the dam (Allen, pers. comm.). Silver salmon respond especially well to this technique and steelhead were generally found to migrate upstream to the trap at a relatively constant rate (Allen, pers. comm.).

The number of salmon and steelhead entering the trap below the dam have varied throughout the trapping operation. High stream flows (over 50 cfs) resulting from spill conditions at Nicasio Dam have created difficulties in the operation of the fish trap and obtaining accurate counts. A summary of the fish counts taken at the trap is shown below.

	<u>Silver Salmon</u>	<u>Steelhead</u>
1960-61	0	34
1961-62	1	35
1962-63	44	1
1963-64	151	129
1964-65	620	83
1965-66	464	8

The absence of silver salmon during the first season of the trap operation (winter 1960-61) is due to the lack of outflow from the dam because reservoir storage was not yet completed. There was also a minimum amount of outflow during the 1961-62 winter season (USGS, unpublished data).

The number of silver salmon trapped below Nicasio Dam does not solely represent the results of natural reproduction on Nicasio Creek and its watershed tributaries. The Department of Fish and Game made a series of fish plants in the Lagunitas Creek drainage to supplement natural silver salmon production. The number and location of fingerling and yearling silver salmon stocked are presented on the table below.

	<u>Nicasio Creek and Tributaries</u>				<u>Lagunitas Creek</u>	
	Above the Reservoir		Below the Reservoir		<u>Fingerlings</u>	<u>Yearlings</u>
	<u>Fingerlings</u>	<u>Yearlings</u>	<u>Fingerlings</u>	<u>Yearlings</u>		
1960						63,702
1961					14,144	
1962					20,001	
1963			9,500	40,125		
1964	50,000	4,454				
1966				40,002		
1967				40,014		

This table represents a total of 184,095 fingerlings and yearling salmon that have been planted in the Nicasio Creek drainage from 1960-67.

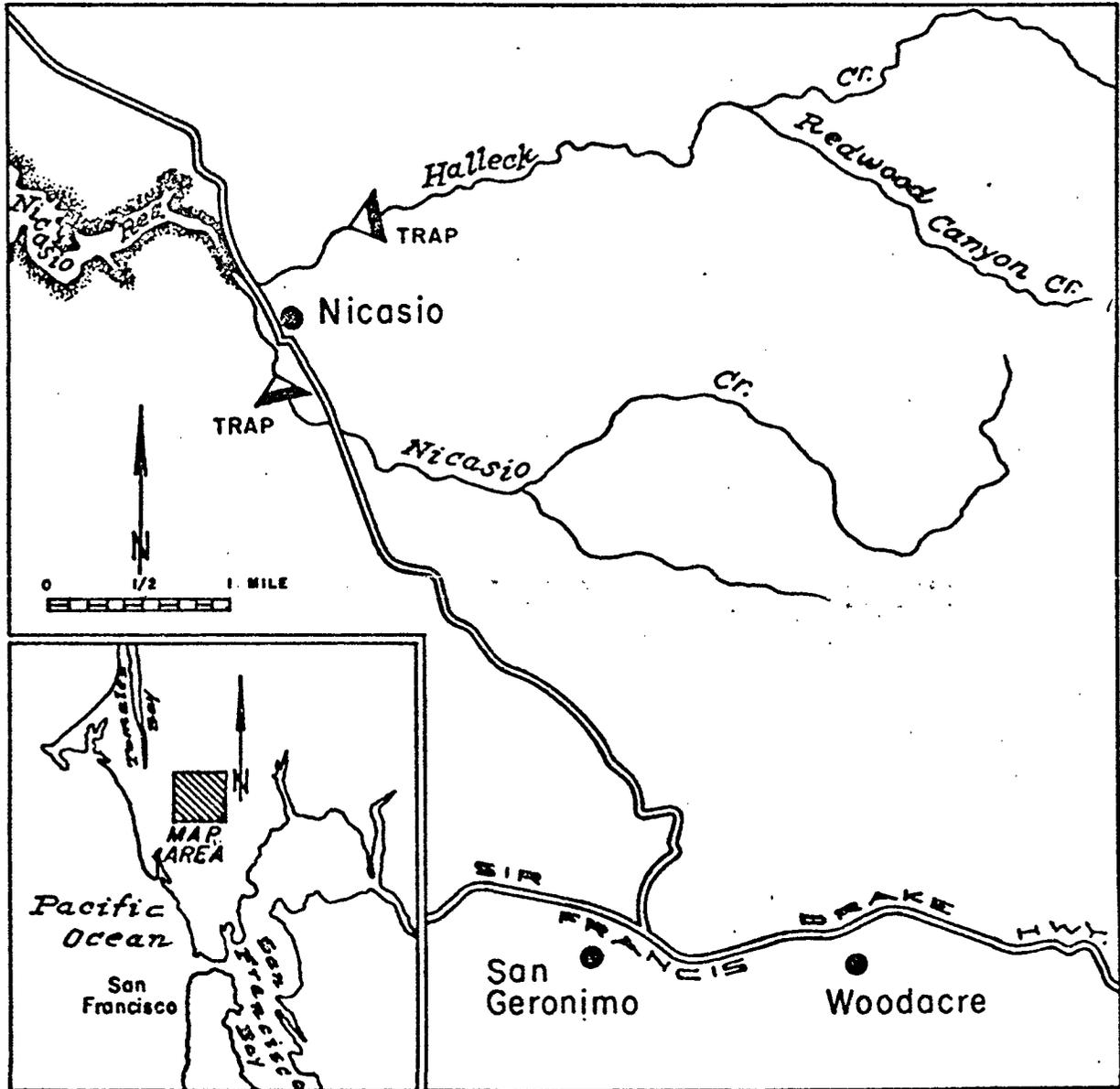
Natural reproduction in the stream resulting from the trapping and relocating adult spawning fish is exhibited by the number of juvenile downstream migrant fish caught at the two trapping stations on the reservoir tributaries. Traps are located on Nicasio and Halleck Creeks about 1/2 mile above the reservoir (see Figure 3). Counts of silver salmon and steelhead trapped at these two sites, excluding planted marked silver salmon are shown below.

	<u>Silver Salmon</u>		<u>Steelhead</u>
1960-61	0		4,522
1961-62	0		2,185
1962-63	--	Records Lost	--
1963-64	916		1,464
1964-65	14,765		156
1965-66	7,171		836

Most of the juvenile salmonids trapped were migrating during April and May as indicated by a 1964 Department of Fish and Game study. Stream flows during April and May of 1964 averaged 0.33 cfs or less and were intermittent in many sections of the drainage. The streamflows on these tributaries are extremely dependent upon rainfall and 1964 was a dry water year.

Spawning and nursery areas available on Nicasio and Halleck Creeks during different runoff conditions are shown in Figure 4.

Figure 3



Nicasio and Halleck creeks, Marin County, California, showing location of reservoir and downstream migrant traps.

Source: California Department of Fish and Game, 1964.

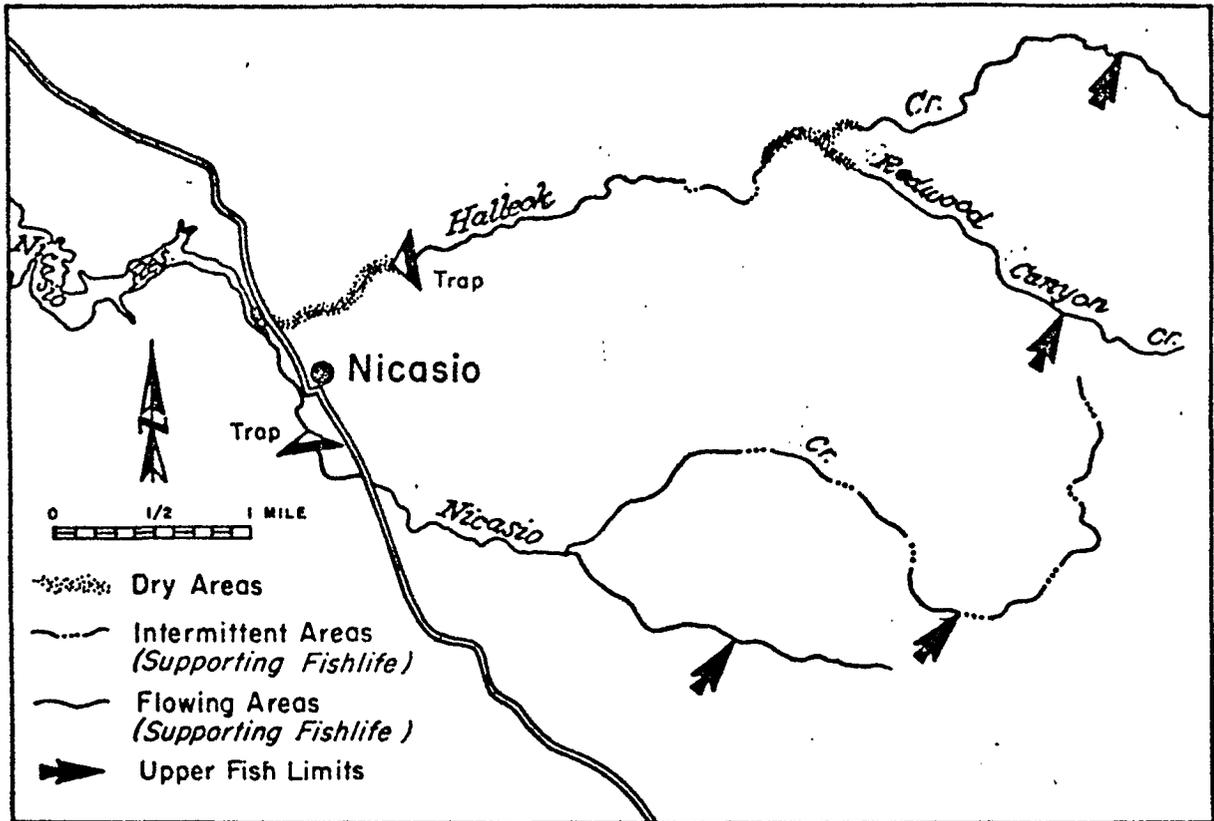
Since Nicasio Dam was completed, the department has conducted yearly studies on the Nicasio project trap and transport operation to obtain the following information:

1. Determine the number, size, and species of downstream migrants.
2. Determine the seasonal migration pattern and the period when traps should be operated.
3. Determine the efficiency of the traps and recommend improvements.
4. Make other observations and collect any additional information relating to the life history of silver salmon and steelhead.

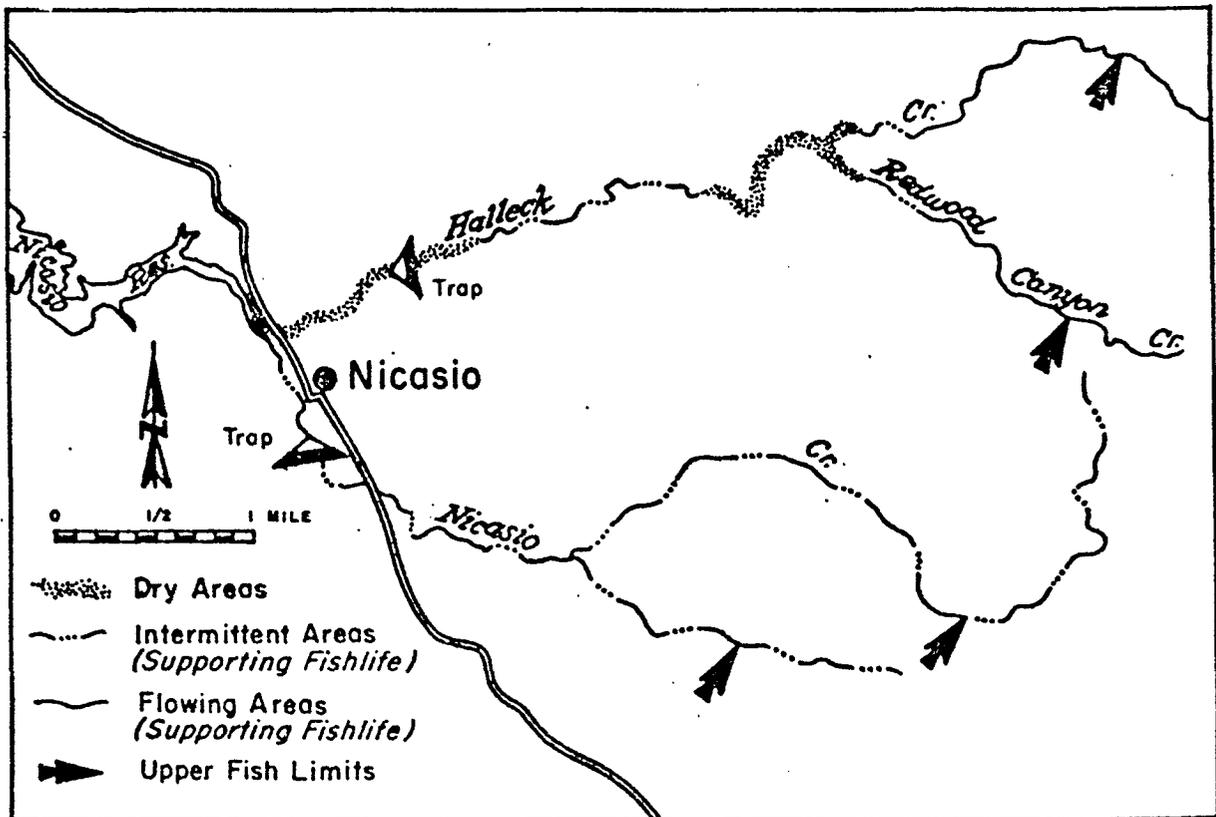
During the course of the Department of Fish and Game's studies several factors have been shown to adversely affect the natural production of juvenile salmonids in the spawning and nursery areas above the reservoir. These factors are: 1) minimum stream flows reducing the available spawning and nursery areas as well as limiting cover needed to escape predation, 2) less than adequate spawning stocks relocated above the reservoir, and 3) competition between native and stocked fish in the nursery area of the two streams.

There are other factors that have affected the post-project fish runs. One is that the silver salmon planted in the Lagunitas drainage have been characteristically early spawners, returning to the drainage during August and September. There are no minimum in-stream flow release requirements at this time of year and fish are sometimes unable to migrate upstream from the estuary. Some of these fish

Figure 4



Nicasio and Halleck creeks, Marin County, California.
Stream conditions existing on August 15, 1963.



Same area, showing stream conditions on September 2, 1964.

Source: California Department of Fish and Game, 1964.

become seriously injured in attempting upstream migration during low flow conditions (Department of Fish and Game letter, 1969).

Water quality conditions on Lagunitas Creek have also adversely affected salmon and steelhead migrations. Occasionally large concentrations of dairy farm wastes entering the stream have caused depressed dissolved oxygen concentrations and fish kills in Lagunitas Creek.

During some spawning seasons, tributaries above Nicasio Reservoir did not maintain sufficient stream flow for spawning. Consequently, flows to attract fish to the trap were not released and fish attempting unsuccessfully to migrate into Nicasio Creek are attracted instead into Lagunitas Creek.

The carrying capacity of streams above the reservoir was the major limiting factor to the production of young fish in Nicasio Creek. This is reflected in the returns to the downstream trap. It was concluded by the Department of Fish and Game that, "The carrying capacity of these streams is not as great as original estimates seemed to indicate". (Department of Fish and Game, 1969)

Original determinations of the carrying capacity of these streams were not discovered from the data reviewed. It might be assumed that the three miles of Nicasio Creek nursery habitat that is presently inundated by Nicasio Reservoir supported a majority of the juvenile salmon and steelhead production during pre-project conditions.

V. Conclusion

Nicasio Dam reduced the magnitude of the natural streamflow in the creek by storage and the diversion of stored water to municipal and industrial areas. The seasonal distribution of streamflow has not changed from pre-project conditions and the period of high stream discharges corresponds with releases reserved for fish and wildlife. The allocation for fish flows is unusual in that each month a prescribed (by terms of 1960 agreement) "block of water in acre-feet" is made available at the beginning of each month according to runoff rates. The Department of Fish and Game designs the release schedule to produce streamflows suitable for passage and attraction of upstream migrants during the release season from November to April. The streamflow alone could not preserve the anadromous fisheries resources due to a limited spawning area resulting from inundation and blockage of all but one mile of Nicasio Creek. However, the manipulation of the streamflow regime did allow fish passage and attraction to an adult fish taking station located at the base of the dam. Captured adults were transported upstream to spawning areas, an operation that was conducted for several years. A study revealed that it was not maintaining the fish populations because of the limited carrying capacity of the upstream spawning and rearing areas.

This method was abandoned and the current agreement between the Department of Fish and Game and the MMWD requires the district to pay for the annual stocking of silver salmon and steelhead fingerlings. It also allows the Department of Fish and Game to operate the trap below the dam when stream-flows are adequate to provide the attraction and passage needs of silver salmon and steelhead.

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